Ludic didactic strategies for meaningful learning in undergraduate students

Estrategias didácticas lúdicas para el aprendizaje significativo en estudiantes de pregrado

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Abstract

The interest in achieving meaningful learning in undergraduate science students, as well as the emergence of new teaching-learning theories, inevitably lead teachers to generate various strategies that allow them to transfer and create knowledge in undergraduates. In this sense, the objective of this article was to evaluate the implementation of ludic didactic strategies in the learning of chemical nomenclature in undergraduate students, that is, how both variables are related. This research was quantitative and qualitative, descriptive and correlational, cross-sectional and the sample population by convenience of 104 students of the Bachelor's Degree in Pharmaceutical Chemistry and Biology. A measuring instrument with 15 items was used, validated by expert judgment and by means of Cronbach's Alpha Index. Data were analyzed with descriptive statistics and hypothesis testing. The findings show that the implementation of ludic didactic strategies by teachers favors learning in chemical nomenclature in undergraduate students. This contributes directly to the state of the art, although there is an evolution in the teaching-learning theories, there are still knowledge gaps in their applicability for educational benefit.

Chemical nomenclature, Constructivism, Gamification.

Resumen

El interés por lograr un aprendizaje significativo en los estudiantes de pregrado en ciencias, así como el surgimiento de nuevas teorías de enseñanza-aprendizaje, llevan inevitablemente a los docentes a generar diversas estrategias que les permitan transferir y crear conocimiento en los universitarios. En este sentido, el objetivo del presente artículo, consistió en evaluar la implementación de estrategias didácticas lúdicas en el aprendizaje de nomenclatura química en estudiantes de pregrado, es decir, cómo se relacionan ambas variables. Esta investigación fue de tipo cuantitativa y cualitativa, descriptiva y correlacional, de corte transversal y la muestra de la población por conveniencia de 104 estudiantes de la Licenciatura en Químico Farmacéutico Biólogo. Se utilizó un instrumento de medición con 15 ítems, validados por jueceo de expertos y mediante el Índice del Alfa de Cronbach. Con estadística descriptiva se analizaron los datos y la prueba de hipótesis. Los hallazgos muestran que la implementación de estrategias didácticas lúdicas de parte de los docentes favorece el aprendizaje en nomenclatura química en los estudiantes de pregrado. Lo anterior aporta directamente al estado del arte, si bien existe una evolución en las teorías de enseñanza-aprendizaje, aún hay brechas de conocimiento, en su aplicabilidad para el beneficio educacional.

Nomenclatura química, Constructivismo, Gamificación

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Introduction

The search for didactic strategies to improve learning in undergraduate students is a constant task for the teaching activity, given the prevalence of lack of knowledge in basic conceptualizations of chemical science, such as chemical nomenclature. These deficiencies are detected from the initial levels of academic training: secondary school, high school and even in their first approaches to this science during the learning units of the university career.

Therefore, learning in undergraduate students continues to be a novel research topic, as an important factor for both the teacher and the student to join in educational innovation, contemplating the new teaching-learning theories, whose main objective should focus on meaningful learning, starting from the identification of previous knowledge as a starting point for the generation of new knowledge, that is, to make sense of the knowledge acquired and above all to achieve self-learning.

Among the obstacles detected by some researchers on the subject of learning chemical nomenclature, it is worth mentioning the confusion of rules after a memorized learning, short term and little reflexive about what is learned. As well as the disconnection between the concepts studied and the belief that this learning is complicated. Also, it is found that the subject taught is isolated from the context of the student, limiting the relationship with the environment and particular interests.

In addition to the above, from the basic educational levels, students are unaware of the reason for using a special language of chemical nomenclature, which is justifiable given the number of existing chemical compounds (Gómez-Moliné et al., 2008). Hence the importance of mastering the essential concepts, not simply memorizing (Hernández, 2008). Another obstacle is the tendency of teachers to replicate the techniques and teaching methods with which they were educated (Maila-Alvarez et al., 2020), which limits their ability to meet the new needs of the teaching-learning process, due to changes in society and in the understanding of human beings themselves.

Accordingly, the importance of this research stands out, where the creation of meaningful learning in students is fundamental for their performance not only academically, but also in their professional life. In addition, this study contributes to the state of the art, theoretically to the teaching-learning theories and empirically by measuring quantitatively the prior and subsequent learning and knowledge of the students, after the implementation of the didactic ludic strategies, identifying the relationship between the variables studied. In this same order of ideas, the different didactic and ludic strategies play an important role, by allowing learning through play in a fun and effective way.

The technique used in this research is both quantitative and qualitative, whose approach is mixed, has an added value with respect to other techniques, on the one hand, a numerical analysis is carried out that allows for generalizable results for the population studied from the sample and, on the other hand, the qualitative analysis allows for complementing the explanation of the problem that occupies this study.

Consequently, in order to clarify the problem to be solved, the research question is formulated as follows: What is the relationship between the implementation of ludic didactic strategies by teachers with the significant learning of chemical nomenclature in undergraduate students? In order to influence the problem, the central hypothesis is established as follows:

H_0: The implementation of ludic didactic strategies by teachers does not have a significant relationship with the meaningful learning of chemical nomenclature of undergraduate students.

H_a: The implementation of ludic didactic strategies by teachers has a significant relationship with the meaningful learning of chemical nomenclature of undergraduate students.

This article is composed of nine sections, which are described below, in order to clarify the content of each one of them. In the first section, there is an introduction to the research topic, the problem to be solved, the hypothesis, the added value of the technique used and the generalities of the research.

In the second section, the literature review is presented, including an overview of the theory supporting the research, which includes teaching-learning and ludic didactic. In this same sense, the third section details the method used, the type and design of the research, the description of the variables, the measurement instrument, the participants, the procedure and the data analysis. The fourth section includes the results and discussion, with descriptive statistics, as well as the discussion in the light of the supporting theory. The fifth section includes the annexes, where the instrument used is included.

The sixth section includes the acknowledgements to the participating teachers and students, as well as to the institution of origin. The seventh section shows the source of financing for the research work. The eighth section presents the conclusions and recommendations, where the main findings, limitations and future work are presented. Finally, the ninth section lists the references of the authors who contribute directly to this study according to the literature review of teaching-learning in university environments.

Literature review

Teaching-learning

Teaching-learning process is conceived not only as a mere transmission of knowledge, but as a process of reconstruction, involving the accumulation of different learning experiences (Piaget, 1950). The techniques used are active cooperative learning as opposed to traditional passive learning.

Now, teaching-learning theory is mainly divided into two major models. The first one refers to teaching, where the teacher is in charge of transmitting knowledge in an expository way, that is, in a master class, where the student only listens. The second model refers to learning, where the student is at the center and the teacher is only a facilitator of learning (Gargallo-López, et al., 2011).

Traditional teaching

Teaching-centered model defines knowledge as an external construction based on the scientific knowledge of a discipline shared by the teacher in an organized manner, who is an expert, understands, dominates, explains and is updated on the topics.

For this, learning is interpreted as the way of acquiring or increasing knowledge in some area to be applied later (Gargallo-López et al., 2011), without considering the students' previous knowledge (Morales et al., 2015).

Accordingly, the teacher with the teaching model uses the lecture and expository lesson, unidirectional communication and eventually changes to bidirectional in the space of questions and answers. In addition, the material used are the teacher's notes based on books and the evaluation of the students consists of repeating what they have learned. Likewise, the teacher performs the tutoring task voluntarily and at a certain time (Gargallo-López et al., 2011). Therefore, teaching is the process by which knowledge about a subject is transmitted (Cabrera-Medina et al., 2016).

Constructivist learning

A very important event in pedagogy is the so-called Copernican revolution, where the focus shifts from teaching processes to learning processes, that is, on the learner. This does not mean that the role of the teacher is unknown, but rather that the figure of the teacher changes to being a guide, a tutor, a facilitator of learning (Tünnermann, 2011). So, the acquisition of knowledge is a process that is incorporated into pre-existing knowledge in the mind of the learner that can be modified or reorganized according to each individual (Piaget, 1950).

Constructivism is a theory of Harré (1986) and Osborne (1996), which has five objectives, the first one refers to the comprehension and expression of scientific messages both orally and in writing. The second refers to interpreting and representing science concepts adequately. The third refers to applying strategies in problem solving. The fourth refers to planning and carrying out scientific activities in teams. Finally, the fifth refers to reasoning based on personal criteria contemplating the era in which one lives (Insausti & Merino, 2000). Constructivist paradigm seeks that students build scientific knowledge for the development of scientific competencies, promoting greater autonomy and participation (Espinosa-Ríos et al., 2016). That is why, the teaching-learning process in universities has changed, it seeks to focus learning strategies on the student and the teacher is cataloged as a guide or mediator for problem solving and application of knowledge (Fernández & Aguado, 2017).

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The constructivism approach conceives the student as responsible for his or her own learning and competencies, which requires the identification of the problem, as well as the knowledge that is available and the knowledge that is desired to investigate for the solution of the problem, with critical and creative thinking. While the teacher is responsible for facilitating the didactic strategy (Lozano-Ramírez 2020). This approach emphasizes the student with his or her knowledge, skills, abilities, expectations, attitudes and conditions to acquire new knowledge (González-Zambrano et al., 2022).

For the construction of knowledge, the establishment of innovative processes of learning environments should be considered, including motivation and co-instructional strategies. Stimulation of the memory of previous learning to develop competencies. Respect for the learner and autonomy. The presentation of pedagogical material and the use of technologies. The ease of appropriation of knowledge; and the linking of previous learning with new learning to be applied in reality (Salgado, 2022).

The learning model based on constructivism focuses on the student and the teacher as facilitator of learning. To this end, knowledge is defined as a social and negotiated construction, it is created and changing. In addition, learning is personally constructed and shared to give meaning to concepts and reality (Gargallo-López, et al., 2011). With this learning theory according to constructivism, the student reaches a significant level of understanding, achieves a conceptual and personal change, with an approach to reality, in addition to passing the subjects (Morales et al., 2015).

In this sense, teaching is understood as an interactive process for the construction of knowledge, where the teacher, in addition to mastering certain topics, must have didactic pedagogical tools to facilitate learning. Interaction with students is bidirectional, and the use of various bibliographic resources is essential to generate critical thinking, dialogue, discussion and teamwork (Gargallo-López et al., 2011). That is why, to facilitate learning, the teacher uses various interactive methods, dialogues or group techniques (Morales et al., 2015).

As a result, learning is the appropriation of knowledge in a critical way (Cabrera-Medina et al., 2016) and evaluation includes case studies, self-assessments, problem solving, rather than exams where knowledge is repeated (Gargallo-López et al., 2011). Now, at the higher education level, the student as the center of the teaching-learning process, it is essential to involve him/her so that learning is created and applied in his/her context (Soltero-Sánchez et al., 2021), in order to meet the new demands in the academic training of the next professionals (Huerta-Chávez et al., 2022).

Meaningful learning

Currently, in educational teaching, the concepts of stimulus, response and positive reinforcement have been replaced by meaningful learning, conceptual change and constructivism. At this time, quality teaching, considered as good, should contribute to conceptual change that facilitates meaningful learning (Moreira et al., 1997). This theory is a response to behaviorism, where activism and learning by discovery were strong (Ordóñez & Mohedano, 2019).

The teacher must contemplate the intellectual capacities of the students for the development and implementation of new didactic strategies. Also, he must socialize and review the current contents and link them with the knowledge generated. The most important thing is to achieve students' motivation to learn, search, collect and create knowledge (Guamán & Venet, 2019).

Consequently, to speak of meaningful learning goes beyond traditional learning, since it not only requires a change in behavior, but also a change in the meaning of the learner's experience. To this end, several elements have an impact on student learning, such as the teachers and the teaching method. Also, the curriculum and the way it is produced. In addition, the social context in which knowledge is developed (Ausubel, 1983).

In this type of learning, the student has a primordial role in generating his or her own knowledge and achieving a balanced cognitive change with individual and social meaning. There must be a willingness to learn, therefore, there must be suitable subsumers in the cognitive structure (Rodríguez, 2004).

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Therefore, it is of great importance to use the knowledge that the student has, so that new learning is generated and becomes meaningful, not memoristic or mechanical (González, 2019).

Thus, the student will learn from the cognitive structure he has, that is, from the concepts and ideas and the way they are organized, which will affect learning in a beneficial way. Therefore, meaningful learning is achieved when a subject is taught in a way that is not arbitrary to what the student knows. Rather, based on what the student knows, a relevant aspect of the cognitive structure is identified and the teaching is carried out (Ausubel, 1983). Therefore, there are two important elements of meaningful learning, non-arbitrariness and substance, i.e., knowledge is not related to any concept but to the most relevant cognitive structure (Moreira et al., 1997).

Then, meaningful learning will occur when new information is connected with a relevant concept that the student possesses, therefore, an anchoring of previous knowledge with the new one is achieved. Not only is an association between knowledge achieved, but new knowledge is created in the cognitive structure, and the student is able to identify the difference, growth and development of knowledge in the subjects he learns (Ausubel, 1983).

Meaningful learning is divided into two types: representational learning and propositional learning. The first refers to individual symbols, such as knowledge of concepts, which leads to generic or categorical representations. The second refers to learning the meaning of ideas expressed by groups of words (Moreira et al.,1997; Ordóñez & Mohedano, 2019). The application of meaningful learning makes students more responsible for their learning, through the construction of knowledge by participating in various interaction activities in which they share their experiences and opinions in groups (Intriago-Cedeño et al., 2022).

Ludic didactic

The aspects of didactic strategies are united in ludic learning, both teaching, learning and evaluation. This turns the teacher's work into an interactive and reflective practice that impacts on teaching innovation. The student is the center of learning and the teacher the driver to achieve the desired learning (Gutiérrez-Delgado et al., 2018).

Gamification

Classic teaching model has been modified by the new educational trends of active student participation, where students actively influence their learning and gamification arises from these trends (Corchuelo, 2018). Gamification is an emerging methodology (Parra-González & Segura-Robles, 2019), it uses the game in contexts different from it (Lozada-Ávila & Betancur-Gómez, 2017), that is, in nonludic contexts (Zaragoza et al., 2016).

Digital games foster creativity, spontaneous learning, abstract thinking and skills development (Zaragoza et al., 2016). In higher education, games will have to be used according to the knowledge to be generated to ensure success (Lozada-Ávila & Betancur-Gómez, 2017). For quality education (Leyva, 2018) it is necessary to incorporate information and communication technologies (ICT) for the development of competencies and skills of both students and teachers.

The purpose of gamification is to ensure that the student meets the learning objectives and the teacher encourages such learning with gamified means, which achieve a link with the expected learning. It is also a mechanism for the understanding of academic content and active student participation. Therefore, it is an opportunity for students to be actively involved in their own learning, motivation, group dynamics, critical reflection and meaningful learning (Oliva, 2016). Gamification incorporates strategies, dynamics, mechanics and specific game content to influence the teaching and learning process in students (Pegalar, 2021).

Then, gamifying is a complex activity, more than a game design, since it involves analyzing the objectives to be achieved and a detailed planning and involvement of the participants (Ortiz-Colón, et al., 2018). Added to this, students play video games, they are gamers by nature, since it is part of their identity. So, using gamification didactic strategies, provoke an interest as motivation for greater and better learning (González-Moreno & Cortés-Montalvo, 2018). Gamification in higher education has an impact on providing better learning opportunities for students, by developing engagement skills, increasing motivation and interest in what is learned (Prieto, 2020), not only because society demands it, but also because schools demand it to facilitate learning (Sánchez-Domínguez, 2023).

Ludic

Ludic refers to the pleasurable and fun action, which is free and voluntary, it may or may not have rules, if there are rules it is a game. Therefore, the game in education has two functions: ludic and educational. The ludic function of games refers to fun and pleasure. While the educational function of games includes understanding, constructing and appropriating knowledge. Games foster motivation, participation, joy and improvement of academic performance, which positively affect the teaching-learning process. These ludic activities do not replace traditional teaching, but optimize the process (Gutierrez & Barajas, 2019).

Play or ludic activity is universal, but changes depending on the cultural environment. However, most people have participated at some time. In communities, through play, they have expressed life situations (Farias & Rojas, 2010). In addition, the game is a learning alternative, didactic games allow the development of skills, combining teaching and fun, being the necessary motivation to achieve meaningful learning, by encouraging critical capacity and self-learning (Martínez & Ríos, 2019).

Games can be classified as: function games, fiction games, construction games, grouping games or games representing the environment. They can also be cooperative, free or spontaneous, with rules or structured, strategy, simulation, popular or traditional, and adaptive structures. The latter are those in which the structure can be modified or redesigned, that is, a new game can be created on the basis of an already known game. This type of game is used for instructional purposes, because it helps to develop a diversity of games based on existing ones such as dominoes, cards or lottery (Farias & Rojas, 2010).

The development of diverse didactic and ludic strategies generates meaningful learning, theoretical knowledge is captured, and recreation, fun, conceptual reflection, debate, commitment and evaluation are made possible. These strategies, different from lectures, eliminate monotony in classes and allow students to be creative and to live new experiences that generate a taste for learning new things. It is noteworthy that these ludic strategies go beyond a simple listening to the lecture by the students, but contemplate the interrelation of previous knowledge with new knowledge, in a dynamic and motivational way (Caicedo, 2019).

The effectiveness of games in educational spaces lies in the fact that it is an activity that is part of the individual, since in addition to being considered as a leisure or entertainment activity, it is now a didactic resource and, therefore, favors learning (López & García, 2020). Consequently, play should be in the whole life of the human being as a fundamental activity for integral development (Caballero-Calderón, 2021). This type of ludic didactic strategies are supported by motivational theories to reinforce the student's performance (Manzano-León, 2021). In addition, by modifying traditional teaching models, they increase students' motivation for learning (Godoy, 2020).

Conectivism

The vertiginous changes since the middle of the previous century in relation to science and technology have caused movements in educational systems (Guamán & Venet, 2019).

Due to these changes, education faces new challenges that imply the generation of new pedagogical and educational perspectives to interrelate technology, communication and education (Bernal-Garzón, 2020).

Connectivism is a new theory of the digital era (Siemens, 2004), with new technologies such as: wikis, social networks, blogs, among others. In addition to having unlimited access to the computer world at the moment, students can control their own learning path (Hernández, 2008). The use of technologies for education improves its quality (Matute et al., 2009). This creates a new scenario for learning, where the role of information technologies becomes relevant (Gutiérrez, 2012). It also highlights the importance of the good use of learning resources such as mind and concept maps, as well as technological tools to design strategies and methodologies to generate interest and motivation in students (González-Zambrano et al., 2022).

In this same sense, the use of technology such as video games, web and social spaces, in teaching-learning with the combination of didactic and recreational situations, help to make learning easier and more fun (Guerrero & Flores, 2019). Now, the theory of connectivism, arises from technology and its impact on learning, part of the chaos and points out the impossibility of predicting, since reality depends on a myriad of uncertain events, one has an impact on another, being the challenge of learning to identify the hidden patterns of existing meanings. It also integrates the theory of self-organization, which depends on the learner's ability to create his or her own connections between information, people or social environments that interest him or her (Siemens, 2004).

This theory states that knowledge and the learning process reside at the same time inside and outside the individual, who is the starting point. Therefore, knowledge is composed of a network connected with others, which by interacting and collaborating feed back the knowledge of the networks generating new and updated learning (Altamirano et al., 2016). Connectivism, then, applies network principles to both knowledge and learning. Knowledge is a pattern of relationships and learning is the creation of new connections and their manipulation (Siemens, 2004).

The principles of connectivism point out that learning and knowledge result from diverse opinions. Therefore, learning is a process of connecting diverse sources of information and may be in non-human artifacts. Likewise, the ability to create more knowledge is important, as facilitating continuous learning and the ability to identify connections between concepts, ideas and topics is paramount. In addition, decision making is a learning process in itself, so what is learned and its meaning has to be seen in a changing reality (Gutierrez, 2012; Siemens, 2004).

For connectivism, all ideas come from other inherited ideas and everything has a root, each concept, thus knowledge networks are formed (Ovalles, 2014). Learning occurs with the condition that the nodes achieve interconnections between the same information needs in order to feed, update and purify the knowledge networks (López & Escobedo, 2021). However, the person responsible for learning is the learner, given that, in the current digital era, the choice of content and its structuring in the learning process plays an important role, where an attempt is made to organize the chaos of knowledge (Sánchez-Cabrero, 2019).

Notwithstanding, this theory, being emergent, faces the challenge of facilitating students to "learn to learn", which implies identifying networks, nodes and self-organization not only according to their interests, but also according to the academic objectives of each subject (Bernal-Garzón, 2020).

Method

Type and design of research

The current research presents a quantitative and qualitative approach, of a non-experimental type with cross-sectional cut (Bernal, 2016; Hernández et al., 2014).

Variables

Ludic didactic strategies variable

Didactic strategies focused on undergraduate student learning, contemplate the ludic activity as a tool for the development and strengthening of the student's cognitive structure, specifically in the subject of chemical nomenclature. It is based on the theory of ludic didactics, gamification and connectivism.

Meaningful learning variable

Teaching-learning strategy that mainly contemplates the student as the center of learning and the teacher as facilitator or guide with the implementation of new didactic methodologies to achieve meaningful learning in students with the topic of chemical nomenclature under the constructivist model.

Measuring instrument

The instrument used to measure the implementation of ludic didactic strategies in the meaningful learning of undergraduate students consisted of 15 items, of which 9 were evaluated on a 10-point Likert scale. The remaining 6 items evaluated qualitative variables, of which, 1 was evaluated in terms of time, 1 was evaluated in terms of knowledge of the three types of nomenclature, 2 evaluated the perception of the games and the preference of these, and the last 2 were open-ended questions regarding the opinion of the didactic strategy in which they participated. This instrument was validated by means of the expert judgment technique and the reliability test was carried out by calculating Cronbach's Alpha.

Participants

The sample was non-probabilistic by convenience (Bernal, 2016; Hernández et al., 2014), which consisted of 104 students of the Bachelor's Degree in Pharmaceutical Chemical Biologist, who voluntarily agreed to participate in the "Chemical Nomenclature Workshop Course", within the scientific and cultural event called "Week of the Pharmaceutical Chemical Biologist".

Procedure

Within the program of the scientific and cultural event called "Week of the Pharmaceutical Chemist and Biologist", we offered the "Chemical Nomenclature Workshop Course" with a duration of 2 hours, which was enough time to implement the didactic and ludic strategies. First, an explanation of chemical nomenclature was given, which included: nomenclature of elements, ancient and current nomenclature, types of nomenclature (systematic, stock and traditional). At the same time, the games portal Cerebriti (https://www.cerebriti.com/) and Aula of Red (https://aulaenred.fundacionibercaja.es/) were used, which are virtual platforms originating in Spain, where free access to ludic didactic tools, i.e., different games as a fun way to learn, is available.

From the Cerebriti platform, the following science games were used: 1) nomenclature of acids and salts, 2) recognize the chemical element, 3) the salts game, 4) playing with hydroxides and oxides, salts, 5) inorganic chemistry formulas, 6) inorganic nomenclature best game ever. While from the Aula of Red platform, inorganic chemistry nomenclature formulation exercises were used for binary and tertiary compounds, relating the formula with the type of stock, systematic or traditional nomenclature.

Likewise, the traditional games catalogued by the theory as adaptable structures were used: Memorama, on the concepts of oxide, hydroxide, anhydride, etc., and review of the endings of hydracid acids, metals with 2, 3 and 4 oxidation states. Dominoes were also used to review the formation of various compounds in molecular form. And as an integrating game, the virtual platform Kahoot (https://kahoot.it/) was used to review what was learned.

Additionally, undergraduate students were recommended some applications to install on their cell phones to continue improving their learning (https://www.quimitube.com/aplicaciones-moviles-para-formulacion-quimica/, https://www.yoformulo.com/, https://play.google.com/store/apps/details?id=com.chemist&hl=es_MX). As well as the book of Chemical Nomenclature by Solis Correa, 2009, published by Patria, which contains an interactive CD for practice.

At the end of the workshop course, after the implementation of the ludic didactic strategies for meaningful learning, the measurement instrument with 15 items was applied virtually, using the Google Forms virtual platform (https://docs.google.com/forms/u/0/), from which the databases were obtained for subsequent analysis.

Data analysis

Data were processed with the statistical program SPSS (Statistical Package for the Social Sciences) version 25 and Microsoft Excel spreadsheet software. Descriptive statistics were used for data analysis, measures of central tendency, graphs and hypothesis testing.

Results and discussion

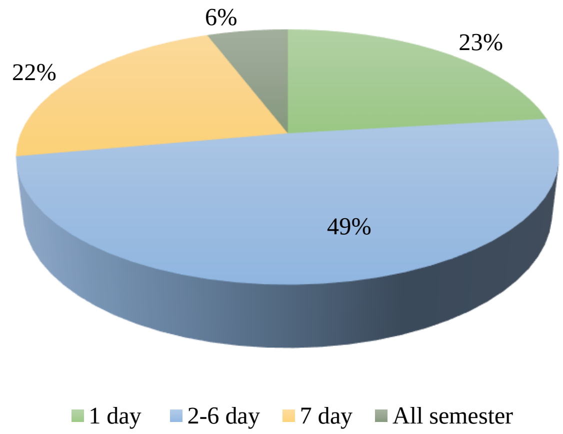
The measurement instrument used, in addition to having been evaluated by expert judgment, the Cronbach's Alpha Index was calculated and presented values above .700 as indicated by Nunnally (1978) and Hair et al. (1999). This proved that the scale is valid and reliable (see Table 1).

Variables	Cronbach's Alpha > .700 (Nunnally, 1978)
LCNSS1, LCNHS2, LCNGC3, KSCE6, KTCN7, KSCN8, KSCN9, ACNC10, ACNLSC11	0.790

Table 1 Calculation of Cronbach's alpha index
Source: Own elaboration, (2023)

Of the 15 items that made up the measurement instrument, 6 of these correspond to qualitative variables, i.e., for their analysis, the responses issued by the students had to be categorized, for subsequent counting and quantitative analysis (Bernal, 2016; Hernández et al., 2014).

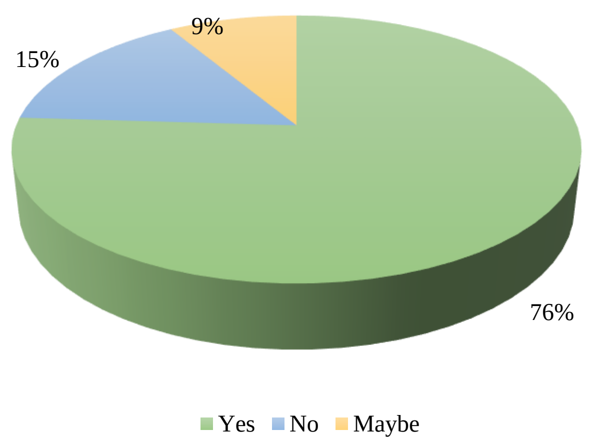
In the case of the item referring to the time dedicated to the study of chemical nomenclature in the learning unit General Chemistry 1, 49% of the students thought that 2-6 days were dedicated to it, but less than a week. Likewise, 23% thought that only 1 day was dedicated to study the topic of chemical nomenclature and 22% thought that the topic was studied in 7 days, equivalent to one week. However, only 6% thought that they saw the subject during the whole semester (see Graph 1).



Graphic 1 Time devoted to the study of chemical nomenclature in the learning unit General Chemistry 1
Source: Own elaboration (2023)

In this sense, the teaching theory stands out, where the teacher is given all the responsibility for transmitting knowledge (Gargallo-López et al., 2011). Therefore, by not devoting enough time to the study of the subject during class hours, it causes a deficiency in student learning. That is why the approach in the learning theory based on constructivism (Harré, 1986; Osborne, 1996) takes great relevance by giving the responsibility for learning to the student.

In relation to the item referring to the knowledge of the types of nomenclature: traditional, systematic and stock. 76% of the students thought that they had knowledge about the types of nomenclature, 15% thought that they did not have knowledge on this subject and only 9% showed an attitude of doubt, answering with maybe (see Graph 2).



Graphic 2 Knowledge of the types of traditional, systematic and stock nomenclature
Source: Own elaboration (2023)

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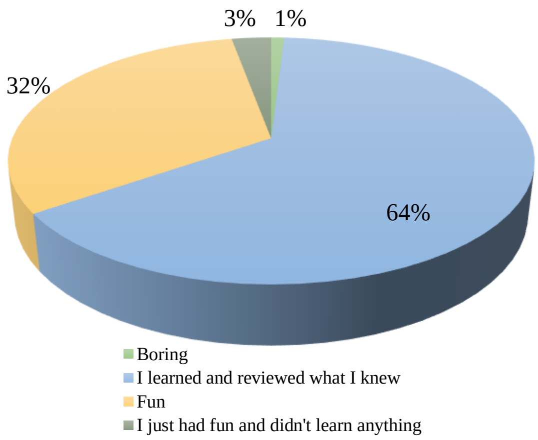
Due to the above, it is important to identify prior knowledge (Morales et al., 2015) and understand that it can be modified or reorganized (Piaget, 1950) for the development of competencies (Espinosa-Ríos et al., 2016). Thus, skills, abilities and attitudes will influence the creation of new knowledge (González-Zambrano et al., 2022).

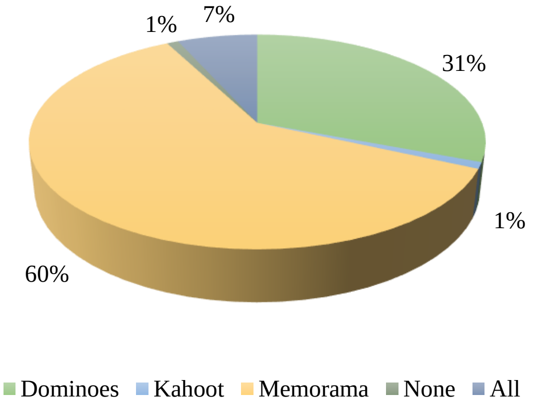
The item referring to the perception of the didactic games used. 64% of the students responded that they achieved learning and also reviewed what they already knew. While 32% of the students thought that the didactic games used during the chemical nomenclature workshop course were fun, 3% thought that they only had fun and did not learn anything. Finally, 1% thought that the games were boring (see Graph 3).



Graphic 3 Perception of the didactic games used
Source: Own elaboration (2023)

In this regard, in order to build knowledge it is extremely necessary to create pleasant learning environments (Salgado, 2022). This becomes a constant task of the teacher by generating interactive and reflective practices (Gutiérrez-Delgado et al., 2018) so that the student achieves his or her own learning.

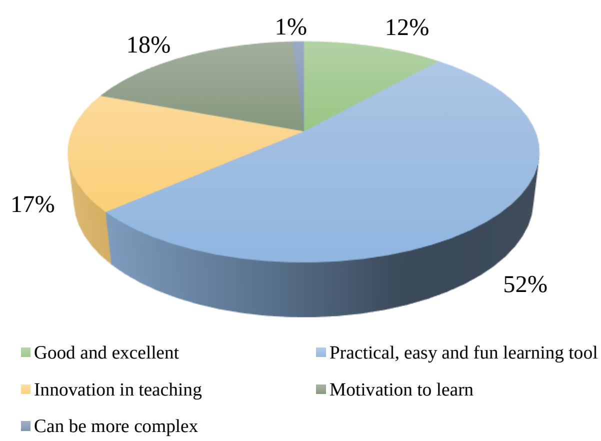
Now, in relation to the item that refers to the effectiveness of the didactic games for learning used during the chemical nomenclature workshop course. The game that most pleased them and helped them to learn was the Memorama, of which 60% agreed with their answer. Next, the Dominoes game obtained 31% of favorable response and 7% of the students thought that all the games were effective. However, 1% leaned towards the Kahoot game, and only the remaining 1% thought that none of them were effective (see Graph 4).



Graphic 4 Effectiveness of didactic games used for learning
Source: Own elaboration (2023)

For the evaluation of the effectiveness of games it is possible to understand that this activity is an important part of the individual, since in addition to being an entertainment activity, in the educational context it becomes a didactic resource that helps favorably in learning (López & García, 2020).

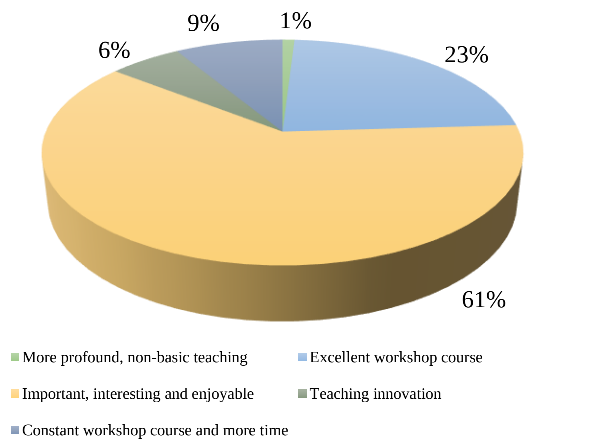
The general perception of the didactic games used for learning in the chemical nomenclature workshop course was also obtained. To this end, 52% of the students thought that they are a practical tool for easy and fun learning. 18% were of the opinion that didactic games serve as motivation for learning and 17% considered them as a form of innovation in teaching. While 12% thought that didactic games are good and excellent. However, 1% thought that more complex didactic games could be implemented compared to those used in the workshop course (see Graph 5).



Graphic 5 General perception of the didactic games for learning used
Source: Own elaboration (2023)

It is here where the importance of the implementation of didactic games for learning becomes relevant. Since games provoke fun and pleasure due to their ludic function. In addition, they promote motivation, participation and joy (Gutierrez & Barajas, 2019), as they are based on motivational theories (Manzano-León, 2021).

The variable related to the general perception of the chemical nomenclature workshop course was measured through the categorization of responses. For this, 61% of the students thought that the workshop course was important, interesting and pleasant. Additionally, 23% thought it was excellent. While 9% thought that this type of workshop course should be held more consistently and for a longer duration. 6% thought that this workshop course, because of the way it was approached, contributes to innovation in teaching. However, 1% mentioned that more in-depth, non-basic teaching should be included (see Graph 6).



Graphic 6 General perception of the chemical nomenclature workshop course
Source: Own elaboration, (2023)

In this sense, the development of the workshop course, as a response to changes in educational systems and technology (Guamán & Venet, 2019), made it possible to interrelate technology, education and communication (Bernal-Garzón, 2020), as a strategy for generating student interest and motivation in a learning environment (González-Zambrano et al., 2022).

On the other hand, for the analysis and interpretation of the 9 quantitative variables of the instrument, measures of central tendency were used. The variables that refer to previous learning of the topic of chemical nomenclature from the educational levels of secondary school (LCNSS1), high school (LCNHS2) and in the learning unit of General Chemistry 1 (LCNGC3), presented values from 1 as minimum and 10 as maximum and the standard deviation obtained values 2 > 3. However, the mean scores were 3.56 for the LCNSS1 variable, 4.52 for the LCNHS2 variable and 6.27 for the LCNGC3. Which demonstrates low levels of prior learning in the subject (see Table 2).

Variable	N	Min	Max	Mean	Standard deviation
LCNSS1	104	1	10	3.56	2.584
LCNHS2	104	1	10	4.52	2.569
LCNGC3	104	1	10	6.27	2.358
KSCE6	103	3	10	7.34	1.432
KTCN7	104	1	10	6.32	1.907
KSCN8	104	1	10	7.01	2.152
KSCN9	104	1	10	6.66	1.831
ACNC10	104	6	10	9.62	0.828
ACNLSC11	104	3	10	9.59	1.094

Table 2 Central tendency measures
Source: Own elaboration (2023)

Regarding the variables that measured the knowledge of the general types of nomenclature (KSCE6) and individualized that includes the traditional (KTCN7), systematic (KSCN8) and stock (KSCN9), only the variable KSCE6 obtained minimum scores of 3 and maximum of 10, and individually in the rest of the variables, the minimum value obtained was 1 and maximum of 10 and the standard deviation values were 1 > 3. The mean values for the variable KSCE6 were 7.34, for KTCN7 were 6.32, for KSCN8 were 7.01 and for KSCN9 were 6.66 (see Table 2).

For the evaluation variables of the workshop course in general (ACNC10) and of the ludic didactic strategies for learning chemical nomenclature (ACNLSC11). For the variable ACNC10, the rating ranges are between 6 and 10, the mean is 9.62 and the standard deviation is 0.828. While for the variable ACNLSC11, the values obtained vary between 3 and 10, the mean is 9.59 and the standard deviation is 1.094 (see Table 2).

Regarding the initial learning (MLI) the minimum value obtained was 1 and the maximum was 10, the mean was 5.98 and the standard deviation was 1.481. For the final learning and knowledge achieved, that is, meaningful learning (MLF) the minimum value was 6 and the maximum was 10, the mean was 9. 62 and the standard deviation was 0 > 1. Finally, the effectiveness of the didactic ludic strategies (EDLS) in the students' meaningful learning had values between 3 and 10 as maximum, the mean was 9.59 and the deviation between 1 > 2 (see Table 3).

Variable	N	Min	Max	Mean	Standard deviation
MLI	104	1	10	5.98	1.481
MLF	104	6	10	9.62	0.828
EDLS	104	3	10	9.59	1.094

Table 3 Central tendency measures
Source: Own elaboration (2023)

To perform the hypothesis test to find the relationship between the variables MLF and EDLS, Pearson's correlation coefficient was calculated. The existence of a very strong relationship between both was detected, thus testing the central hypothesis, where the null hypothesis is rejected and the alternative hypothesis is accepted, i.e., the implementation of ludic teaching strategies by teachers has a significant relationship with the meaningful learning of chemical nomenclature of undergraduate students (see Table 4).

		MLF	EDLS
MLF	Pearson´s correlation	1	.466**
	Sig. (bilateral)		0.000
	N	104	104
EDLS	Pearson´s correlation	.466**	1
	Sig. (bilateral)	0.000	
	N	104	104

Table 4 Cronbach's alpha index calculation
Source: Own elaboration (2023)
** The correlation is significant at the 0.01 level (bilateral).

The above shows that, at present, it is necessary that in the different educational levels, ludic didactic strategies for learning the subject of chemical nomenclature are implemented, especially in higher education levels, where this subject is fundamental in the formation of future professionals, who will go out into the world, to avoid deficiencies in basic conceptualizations, promoting a successful development of their profession.

Without leaving aside the commitment that the educational institution has with society to form better professionals.

The teacher's work is also relevant, since it must take into account the intellectual capacities of students, in order to generate new didactic strategies for learning and encourage students to be motivated to learn, seek and create their own knowledge (Guamán & Venet, 2019). Learning will be meaningful, as long as it is possible to connect a relevant concept that the student already has with new knowledge, i.e., an anchorage between knowledge must be achieved (Ausubel, 1983).

Finally, ludic didactic strategies for learning are relevant to develop skills in students, resulting from the combination of teaching and fun, as well as motivation to achieve meaningful learning (Martínez & Ríos, 2019).

Annexes

The items evaluated in the instrument are shown below (see Table 5).

Variable	Item
LCNSS1	Learning in chemical nomenclature in secondary school.
LCNHS2	Learning in chemistry nomenclature in high school.
LCNGC3	Learning chemical nomenclature in General Chemistry 1.
TIMECN4	Study time of chemical nomenclature in General Chemistry 1.
TYPECN5	Knowledge of chemical nomenclature types: traditional, systematic and stock.
KSCE6	Knowledge of the symbols of chemical elements.
KTCN7	Knowledge of traditional chemical nomenclature.
KSCN8	Knowledge of systematic chemical nomenclature.
KSCN9	Knowledge of stock chemical nomenclature.
ACNC10	Assessment of the chemical nomenclature workshop course.
ACNLSC11	Assessment of chemical nomenclature learning ludic strategies.
PDGL12	Perception of didactic games for learning used.
EDGL13	Effectiveness of didactic games for learning used.
PDGL14	General perception of the didactic games for learning used.
GPCNC15	General perception of the chemical nomenclature workshop course.

Table 5 Items and variables of the instrument applied
Source: Own elaboration (2023)

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Conclusions and recommendations

The evolution of the teaching-learning theory, the emergence of new theories such as constructivism, meaningful learning, ludic, gamification and connectivism. In which the student is increasingly made responsible for his own learning and the role of facilitator or guide is given to the teacher. It is possible to conclude that it is imperative to design new didactic strategies that include both information technology tools and face-to-face activities, in order to involve students in their learning and make it meaningful.

The purpose of this is that the student is the one who manages his or her own learning. By reviewing the constructivist theory, it is possible to conclude that learning must be created by the student himself and at the same time achieve meaningful learning, which starts from previous knowledge and integrates the new one. Without losing sight of the fact that the ludic theory, gamification and connectivism, which contemplates the game and technology as a ludic didactic tool, is extremely necessary in the digital era.

A great challenge facing educational research is to teach students to "learn to learn". That is why the role of the teacher has not been distorted; on the contrary, now, in addition to being knowledgeable about the subjects, he must have pedagogical didactic skills to promote learning. This does not detract from the fact that learning is found in each individual, who is responsible for selecting the learning content, which must be linked to the objectives of each subject.

The main limitations faced by this research were the selection of the sample, since it was non-probabilistic and by convenience, so that the generalization of results is exclusively to explain the behavior of the variables studied in the context described. The data analysis was limited to the use of descriptive statistics. Therefore, as future work, it is recommended to use a probabilistic sample and to incorporate inferential statistics in the analysis of the information, which will have an impact on the reduction of the knowledge gaps in the topic of study of this research.

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